

BALANCE™

HYBRID ▲ ELECTRIC
AZURE DYNAMICS

Specifications & Ordering Guide
2009/2010 Ford E-450 Cutaway & Stripped Chassis



SPC500751-C
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AZD develops proprietary electric and hybrid electric drive technology for the light to heavy duty commercial vehicle markets.

AZD has expertise in the areas of vehicle controls software, power electronics, electric machine design, vehicle systems engineering and vehicle integration. The principal business of AZD is the supply of hybrid electric vehicle and electric vehicle control and powertrain systems.

AZD is headquartered in Detroit with offices in four centers across North America and is a public company trading on the Toronto Stock Exchange TSX (AZD) in Canada.

Balance™ Hybrid Electric Overview

This vehicle is built on a Ford E-450 commercial stripped or cutaway chassis with a modified drivetrain and modified electronic controls system. AZD's Balance™ Hybrid Electric Drive System significantly reduces fuel consumption due to the following features:

- Engine stop/start capability
- Regenerative braking
- Electric-only mode at low speeds
- Electric launch-assist

The vehicle is propelled by the Traction Motor in parallel with the conventional gasoline engine and automatic transmission. The Traction Motor assists acceleration and captures energy during regenerative braking events. This energy is stored in the Energy Storage System (ESS).

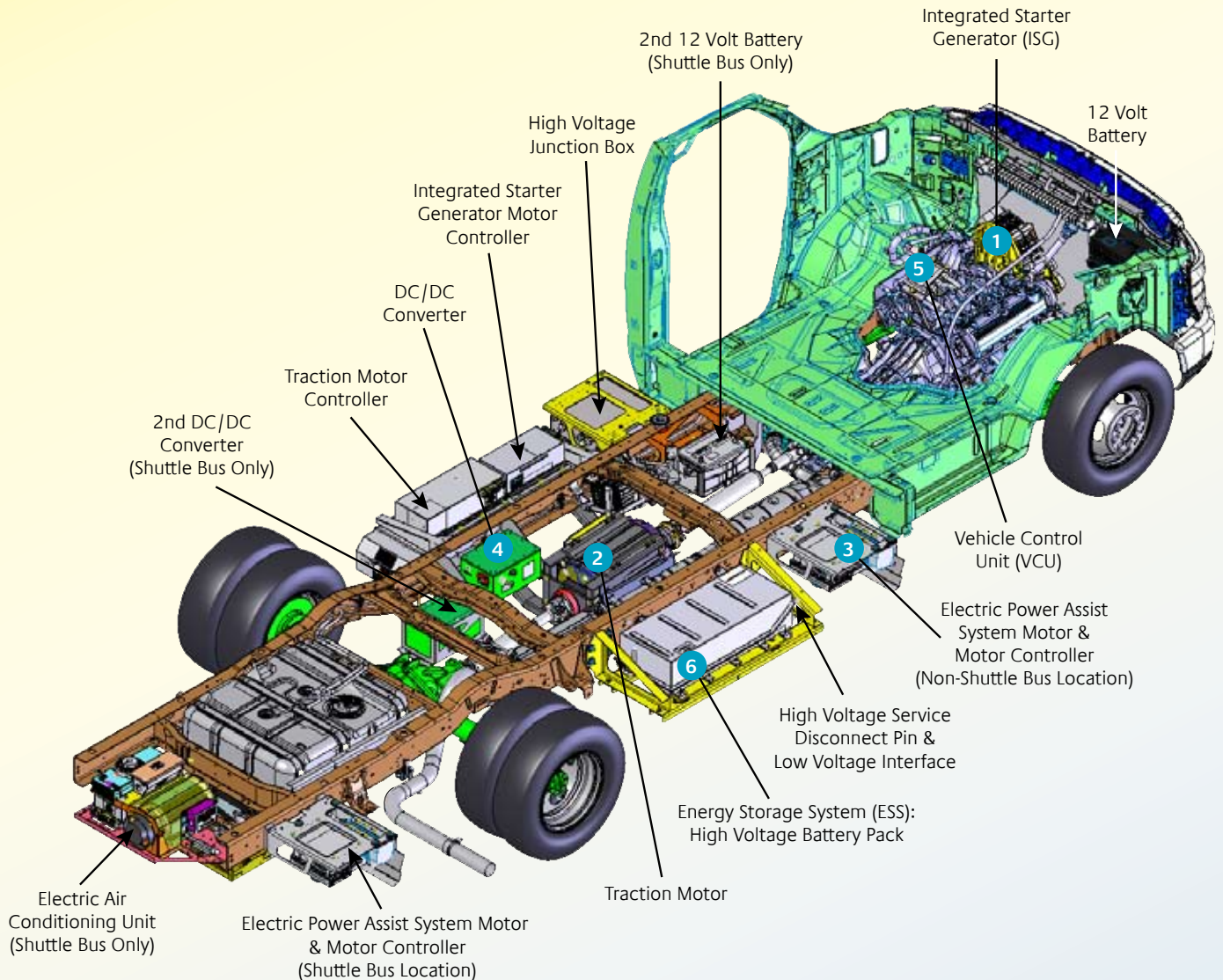
When the vehicle comes to a stop (e.g. at a red light), the engine will typically shut off in order to save fuel. When this happens, the Electric Power Assist System and DC/DC are enabled to maintain power steering, power brakes and 12 volt charging.

The vehicle also has an Integrated Starter Generator (ISG) mounted to the front of the engine which is used to provide quick re-starts of the engine when accelerating from a stop. It also generates power to charge the ESS.

The high voltage system is self-contained and it does not have to be plugged in to an external power source for charging.

AZD's Balance™ Hybrid Electric Drive system will make a difference to your bottom line and your carbon footprint by offering up to 40% savings in fuel economy, up to 30% reduction in maintenance costs and up to 30% reduction in greenhouse gas emissions.

Balance™ Hybrid Electric Architecture



- 1 Integrated Starter/Generator (ISG) is used to start the engine and to generate power.
- 2 Traction Motor is used to propel the vehicle and to provide regenerative braking.
- 3 Electric Power Assist System (EPAS) supplies hydraulic assist for brakes & steering when engine is off.
- 4 DC to DC Converters step down high voltage from the Energy Storage System (ESS) to maintain charge on the 12V system when the engine is off.
- 5 Vehicle Control Unit (VCU) controls all hybrid components and coordinates their operation with the Ford systems (e.g. start/stop).
- 6 Energy Storage System (ESS) stores energy and operates in the 200 to 400V DC range.

Hybrid Electric Drive System Specifications

Manufacturer	Azure Dynamics
Model Year	2009/2010
Model	Balance™ Hybrid Electric (Parallel Hybrid)
Motor	100 kW AC induction w/ regenerative braking
Motor Controller	120 kW Inverter
Transmission	Elect. 5-Spd Torqshift Auto O/D Transmission
Battery	288V, 60kW, 8.5 Ah, maintenance-free nickel metal hydride Automatic high voltage disconnect in case of vehicle collision
System Voltage	288V DC Nominal
Power Steering/Brakes	Engine on – standard engine driven pump Engine off – electrically driven secondary pump
Low Voltage System (12V)	Alternator supplemented by DC/DC converter
Cooling ¹	Engine – Ford cooling system with electrified radiator cooling fans Hybrid system – Separate low temperature cooling loop
Engine	Ford 5.4L EFI FFV Gasoline V8 Engine (50 State)

Note:

- Overheating protection strategies may derate engine power when operated on extended grades above 4% when the ambient temperature is 43°C (110°F) or above.

Hybrid Electric Drive Specification (Shuttle Bus Only)

ITEM	DESCRIPTION
Body Air Conditioning	Standard Ford Engine driven dash air conditioning system. Body air conditioning provided by an electrically driven compressor (TM-16 recommended) which is capable of 55,000 BTU/hr (IMACA) capacity ^{1,2,3} .
Low Voltage System (12V)	Two DC/DC converters (1,500 watts each) standard on shuttle bus to supplement Ford alternator. Automatic high idle mode for 12V system loads when in PARK.

Notes:

- As per the Azure Body Builders Layout Book Supplement, Document MAN500721
- This system has passed the Houston and MSBMA Pulldown tests when tested on 22 foot bus.
- When the vehicle is stationary, capacity may drop to 40,000 BTU (IMACA) after 10 minutes of idling at 110°F ambient temperature.

Added Curb Weight (lbs) due to Hybrid System

MODEL	WHEELBASE	FRONT (lbs)	REAR (lbs)	TOTAL (lbs)
Stripped or Cutaway	158"	730	710	1440
Stripped or Cutaway	176"	800	640	1440
Cutaway Shuttle Bus prep.	158"	636	1029	1665

Note:

- These weights all assume that the energy storage system is a 288V NiMH battery pack.

Chassis Mandatory Specifications

ITEM	DESCRIPTION	FORD OPTION CODE
Model Year	Must be model year 2009 or 2010	
Chassis	E-450 Cutaway or Stripped Chassis	E45/E4F or E49/E4K
Engine	5.4L EFI FFV V8 Gas Engine	99L
Transmission	Elect. 5-Spd Auto O/D Transmission with Tow-Haul ⁴	44T
Alternator	155 Amp Alternator	63M
Front GAWR	Front Max GAWR (5000 lbs)	672
Wheelbase	158" or 176" (except shuttle bus—see below)	158WB or 176WB
GVWR	14,050 lbs	206
Rear Axle Ratio	4.56 Non-Limited Slip	X83
Emissions	50 State Emissions	425

Notes:

1. All customer desired chassis specs to be reviewed by Azure Dynamics in advance of order.
2. Single Rear Wheel (SRW) cannot be accommodated.
3. Suggest that the smallest fuel tank option be ordered with chassis to maximize payload or passenger capacity.
4. Although the tow-haul transmission feature is required (option 44T), this feature will not be selectable by vehicle operator since the hybrid system takes control of it.

Shuttle Bus Chassis Mandatory Specifications (In addition to above)

ITEM	DESCRIPTION	FORD OPTION CODE
Battery	Battery, heavy duty auxiliary	634
Wheelbase	158" is the only wheelbase available	158WB

Incompatible Chassis Specifications

ITEM	DESCRIPTION	FORD OPTION CODE
Traction Control	Engine only traction control	15T
Anti-Theft	2 key recognition	CEI
Battery	Battery, heavy duty auxiliary ¹	634
Speed Control	Vehicle speed control (cruise control)	525
In Dash Computer	In Dash Computer / Touch Screen	98A
Crew Chief	Telematics System	85C
Trailer Towing Package	Trailer Tow Prep Package ²	534

Notes:

1. Heavy duty auxiliary battery is a mandatory option for shuttle bus chassis only, however not compatible otherwise.
2. No trailer towing capacity available.

Ford Qualified Vehicle Modifier (QVM) Drop Ship & Ship Thru Codes

AZD has been QVM certified by Ford Motor Company and has been assigned the following codes:	
Drop Ship Code	860177 (to Utilimaster, Wakarusa, Indiana)
Ship Thru Code	31G, D9D

Note:

1. Additional fees apply to utilize Ford's ship thru process. Please contact AZD for pricing information.

Body Specification¹

Mud Guards	The Body Builder must install mud guards in front of rear wheels and behind front wheels in order to protect the hybrid components.
Heating	Cab heating supplied when engine is shut down.
Minimum Body Height	All bodies must extend to approximately the bottom of the frame rail in order to protect the hybrid components that are mounted to the frame rails.
Minimum Body Width	Minimum Body width must be at least 86.5 inches (inside) in order to clear the hybrid components that are mounted outboard of the frame rails.
Sign-off of Hybrid System	The Body Builder must follow the Azure Body Builders process for sign-off of the hybrid system.
End of Line Test	The Body Builder must complete a 20 minute end-of-line road test with the hybrid system enabled.

Note:

- As per the Azure Body Builders Layout Book Supplement, Document MAN500721

Performance Specifications

Top Speed	Electronically limited to 67 mph (108 kph) on strip chassis applications and 72 mph (116 kph) on cutaway chassis applications.
Acceleration	Acceleration power within 10% of stock vehicle.
Emissions	Engine meets all EPA and CARB emission standards – see data below for comparison to baseline conventional chassis.
Anti-Idle	Anti-Idle Compliant – Auxiliary systems 100% capable with engine off: <ul style="list-style-type: none"> • 12V DC (low voltage) • Air Conditioning (shuttle bus only) • Power Steering/Braking Engine runs to charge the high voltage energy storage system and automatically shuts down.
Braking	Braking deceleration rates same as conventional. Regenerative braking reduces brake wear.
Engine Starting	Nearly all engine starting is managed by an integrated starter motor/generator, the rest is handled by the conventional starter. Significant improvements in conventional starter life will be experienced.
Reliability	Redundant systems keep the vehicle operational in case of hybrid system fault.

Fuel Economy & Emissions Testing Results

	FUEL ECONOMY*		EMISSIONS (g/mile)*			
	(mpg)		HC	CO	NOx	CO ₂
Baseline	4.99		0.598	6.823	0.271	1769
Hybrid	6.64		0.308	4.514	0.229	1335
Percentage Improvement	33%		48%	34%	15%	25%

*NYCC Chassis Dynamometer Cycle—Results on model year 2009 E-450

Warranty Coverage at a Glance*

COVERAGE	TIME	MILEAGE	PROVIDER
Ford System	See Ford Warranty Policy—Standard warranty applies		Ford
Hybrid System	5 Years	60,000 miles	Azure

* The warranty coverage applies until the maximum time or mileage, whichever comes first. The warranty remains with the vehicle regardless of ownership.

Please note: The above warranty information is intended as an overview only for on-road applications.

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